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## Summary

Land snails and slug are considered of an economic importance among the animal pests attacking different types of crops. In Egypt , The land snails *Eobania vermiculata* and the slugs *Deroceras reticulatum* are known as dangerous pests to ornamental plants, orchard trees and different crops.

The present study was undertaken to evaluate the efficacy of two selected insitcicides-namely cidial and carbaryl ( which are commonly used for controlling most agricultural pests) against the land snails *Eobania vermiculata* and the slugs *Deroceras reticulatum*. The cidial organophosphrous compound showed the highest mollucicidal effect comparing with the used carbamate compound (carbaryl)

The obtained results were summarized as follows:

The pesticide LC<sub>50</sub> of cidial for the slug *Deroceras reticulatum* and the snail *Eobania vermiculata* was found to be 2800 and 5200 ppm. respectively. Where as the pesticide LC<sub>50</sub> of carbaryl for the slug *D. reticulatum* and the snail *E. vermiculata* were found to be 9000 and 12000 ppm., respectively.

### **Evaluation of the chronic toxicity of the cidial and carbaryl for six weeks:**

The slug *Deroceras reticulatum* showed the highest susceptibility to toxicity of the cidial organophosphorus compound depending on the treatment concentrations and period of treatment. Highest drastic effect was detected at 6<sup>th</sup> week in case of the slug.

Application of the different concentration levels of carbaryl revealed much more molluscicidal effect against the slug than the snail especially after 6<sup>th</sup> week-treatment. However, the cidial organophosphorus exhibited the most potent effect against the snail and the slug.

### **Histological observations:**

#### **1-Digestive gland:**

*Eobania vermiculata* treated with 1/10 & 1/4 LC<sub>50</sub> of cidial (520 & 1300 ppm) showed comparatively atrophy of lumina of the tubules, swelling of digestive cells and vacuolation of secretory cells. Highest drastic effects were detected after application of 1/4 LC<sub>50</sub>.

Experimental group treated with 1/10 & 1/4 LC<sub>50</sub> of carbaryl (1200 & 3000 ppm) showed less drastic effect comparing with the cidial insecticide. The structure architecture and integrity of the tubules were disturbed. The digestive cells became deteriorated and vacuolated. The free border of the cells toward the lumina were markedly lysed and degenerated. The lumina appeared abnormally narrower and enclosed by clusters of cell debris

The slug *Deroceras reticulatum*, treated with 1/10 & 1/4 LC<sub>50</sub> of cidial (280 & 700 ppm) displayed massive histological changes in the form of irregular lumen borders and either swollen or massive deterioration of the digestive cells associated with cytoplasmic vacuolation. Massive pathological alterations were observed post higher dose-treatment.

On the other hand, treatment with 1/10 & 1/4 LC<sub>50</sub> of carbaryl (900 & 2250 ppm) induced massive breakdown of the

architecture of the digestive gland cells. The different kinds of digestive cells appeared swollen and degenerated. The lumen became enclosed with cell debris and other cytoplasmic inclusions. Higher pathological alterations were detected after application of higher dose treatments.

## **2-Histological structure of the ovotestis:**

In experimental *Eobania vermiculata* treated with 1/10 & 1/4 LC<sub>50</sub> of cidial exhibited marked reduction of spermatogenic cells. Many of the acini appeared atrophied. The germinal epithelial cells were distorted and degenerated. Highest drastic effect was detected after application of 1/4 LC<sub>50</sub> and characterized by massive degeneration of both male and female germ cells.

On the other hand, treatment with 1/10 & 1/4 LC<sub>50</sub> of carbaryl showed less adverse effect comparing with cidial. The histopathological alterations manifested by moderate sloughing and degeneration of acini and spermatogenic cells. There was a considerable reduction of spermatogenic cells being increased with increasing concentration of treatment.

In case of the slug *Deroceras reticulatum* treatment with 1/10 & 1/4 LC<sub>50</sub> of cidial exhibited massive degeneration of both male and female germ cells and more pronounced in higher concentration-treatment. The most histological alterations were reduction of spermatogenic cells, massive breakdown of connective tissue elements ensheathed the acini.

On the other hand, treatment with 1/10 & 1/4 LC<sub>50</sub> of carbaryl exhibited a slight alterations comparing with both levels of cidial.

Few numbers of spermatids were identified in the acini. In higher concentration treatment, spermatozoa accumulated with sign of fragmentation or hyaline degeneration and lack of normal criteria structure.

### **3- Histological structure of the neurosecretory cells:**

In case of *Eobania vermiculata* , treatment with 1/10 & 1/4 LC<sub>50</sub> of cidial showed numerical loss of neuronal cells. The affected neuronal cells appeared atrophied with either pyknotic or degenerated nuclei and became loosely contacted with each other. The structure forming the commissure becoming spongy with sign of degeneration. Some vacuoles and deterioration of some cells were observed. The perineurium connective tissue sheath detached from the underline neuronal cells with sign of forming vacuoles in the underlying tissues. Highest adverse effect was observed on higher concentration treatment.

Treating the slug *Deroceras reticulatum* with 1/10 & 1/4 LC<sub>50</sub> of cidial, led to numerical reduction of neuronal cells . Most of them appeared swollen with karyolytic nuclei. The matter of commissure appeared fragile with signs of necrosis in different parts. Higher concentration-treatment with cidial revealed massive histological alteration. In experimental group treated with 1/10 & 1/4 LC<sub>50</sub> of carbaryl, the neurosecretory cells showed less drastic effect comparing with cidial. Few number of neuron cells was degenerated. The neurons appeared considerably atrophied.

Higher drastic effects were reported post –application of 1/4 LC<sub>50</sub> of carbaryl.

#### **4-Histological structure of the foot:**

At the light microscopic level, in the experimental *Eobania vermiculata* group treated with 1/10 & 1/4 LC<sub>50</sub> of cidial, there were drastic histopathological alterations manifested by losing of epithelial cells cilia, numerical increase of mucocytes, widespread of haemorrhagic spots and presence of numerous dark-brown spots of varying sizes in the connective tissue. Highest drastic effects were observed after application of higher dose-treatment.

In case of *Deroceras reticulatum* treatment with 1/10 & 1/4 LC<sub>50</sub> of cidial, similar histopathological defects were detected as in *Eobania vermiculata*.

On the other hand , treatment of 1/10 & 1/4 LC<sub>50</sub> of carbaryl caused some pathological changes in the foot layers of the snail *Eobania vermieulata*; the epithelial cells lost most of their cilia, many vacuoles appeared in the connective tissue and muscle fibers. The drastic effects increased after application of the higher dose-treatment.

Application of 1/10 & 1/4 LC<sub>50</sub> of carbaryl on *Deroceras reticulatum*, led to less pathological changes comparing with cidial, however many histopathological changes were observed including losing of epithelial cells cilia and vacuolated dermal layer. Highest degenerative phases of epithelial layers were detected after application of higher dose –treatment.



TEM observations of experimental *Eobania vermiculata* group treated with 1/10 LC<sub>50</sub> of cidal (520 ppm) revealed a considerable deformation of cilia which were swollen and shortened losing their uniform shape. The nuclear membrane became irregular without necrotic changes in the two cell types. The mucocytes showed degeneration or consumption of mucous and the containing sac. Some dark electron-dense granules were observed in multivesicular bodies within the cytoplasm.

In case of *Deroceras reticulatum*, 1/10 LC<sub>50</sub> of cidal caused severe damage and deformation of the epithelial cells of the slug. The cilia were pinched off and many pinocytotic vesicles were observed at the apical surface of the cell. Electron-dense granules were observed in the pinocytotic vesicles at the cell surface. The epithelial cell nucleus had undergone karyolytic degeneration. The mucocytes activated mucous expelling on the cell surface although mucous granules were noted to be more electron-dense than in control ones and cytoplasmic organelles lost their normal shapes.

**Combined effect of different photoperiods & used insecticides on the ovotestis of the slug and snail:**

In case of the slug *Deroceras reticulatum*, the mortality rate increased gradually by time and with increasing the concentration of the molluscicides under the short-day photoperiod, but this mortality rate decreased under the long-day photoperiod. Different histopathological changes were recorded including degeneration of the germinal epithelium, disturbed gametogenesis, empty acini spaces, fragmentation of the spermatozoa and deterioration of the mature ovum. The present results showed that

the cidial molluscicide was more effective than carbaryl under all the photoperiods.

In case of the snail *Eobania vermiculata*, the mortality percentage increased gradually by time and with increasing the concentration of the molluscicide under the short-day photoperiod, but this mortality rate decreased under the long-day photoperiod. Treatment of the snails with carbaryl or cidial under various photoperiods caused massive degeneration of the germinal epithelium lining the acinus, the spermatozoa accumulated in few nests, vaculated mature ovum appeared and presence of shranked acini. The present findings showed that the cidial molluscicide showed the highest molluscicidal effect comparing with the carbaryl compound.

From the above results it could be concluded that the organophosphorus insecticide, cidial is more toxic against the land snail and slug studied and less of cost comparing with carbaryl compound. Hence, it is recommended to be used as a pest gastropods molluscicide to control their increase and destruction of vegetative areas and crops.

